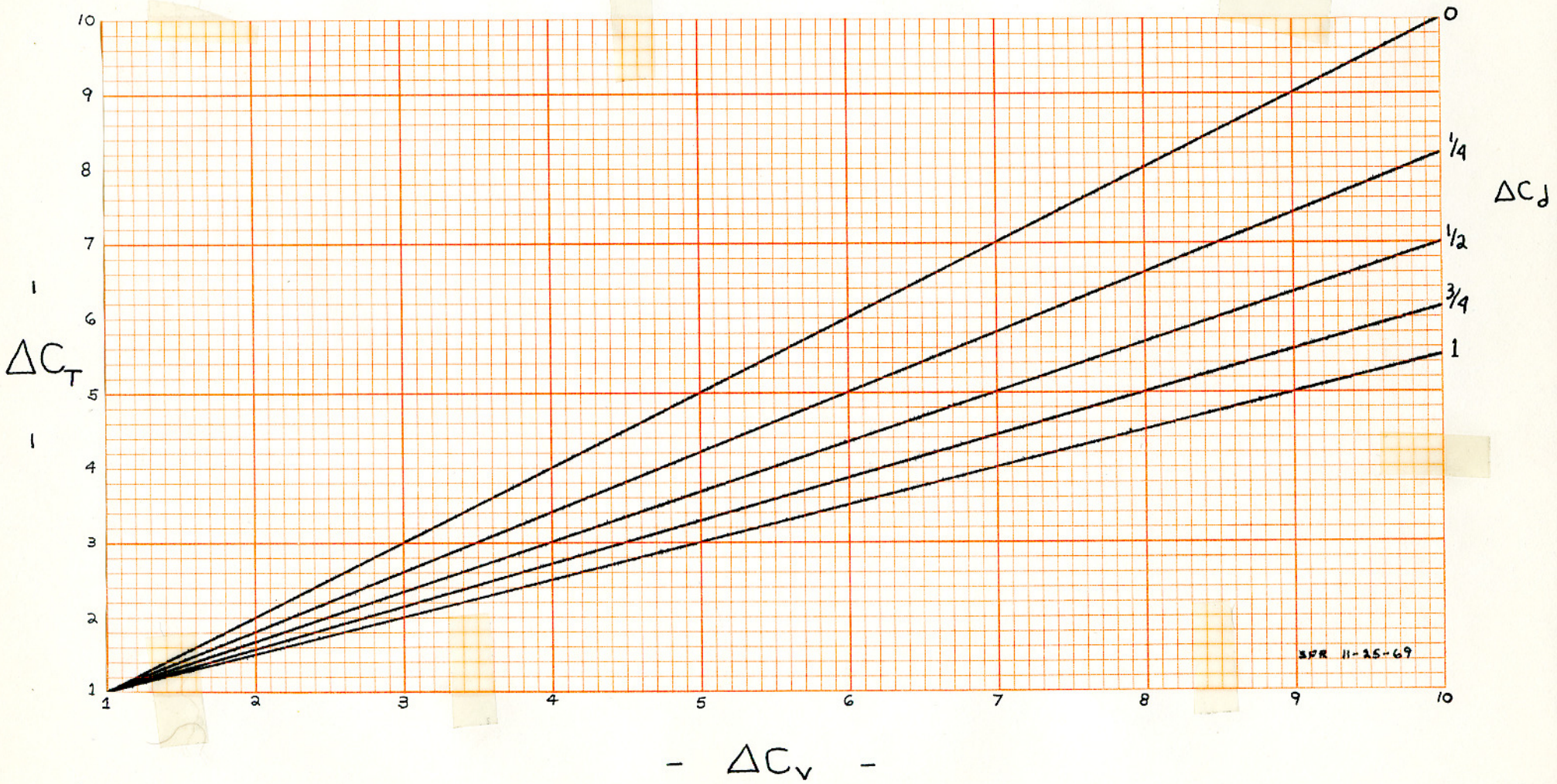


Figure 1-9

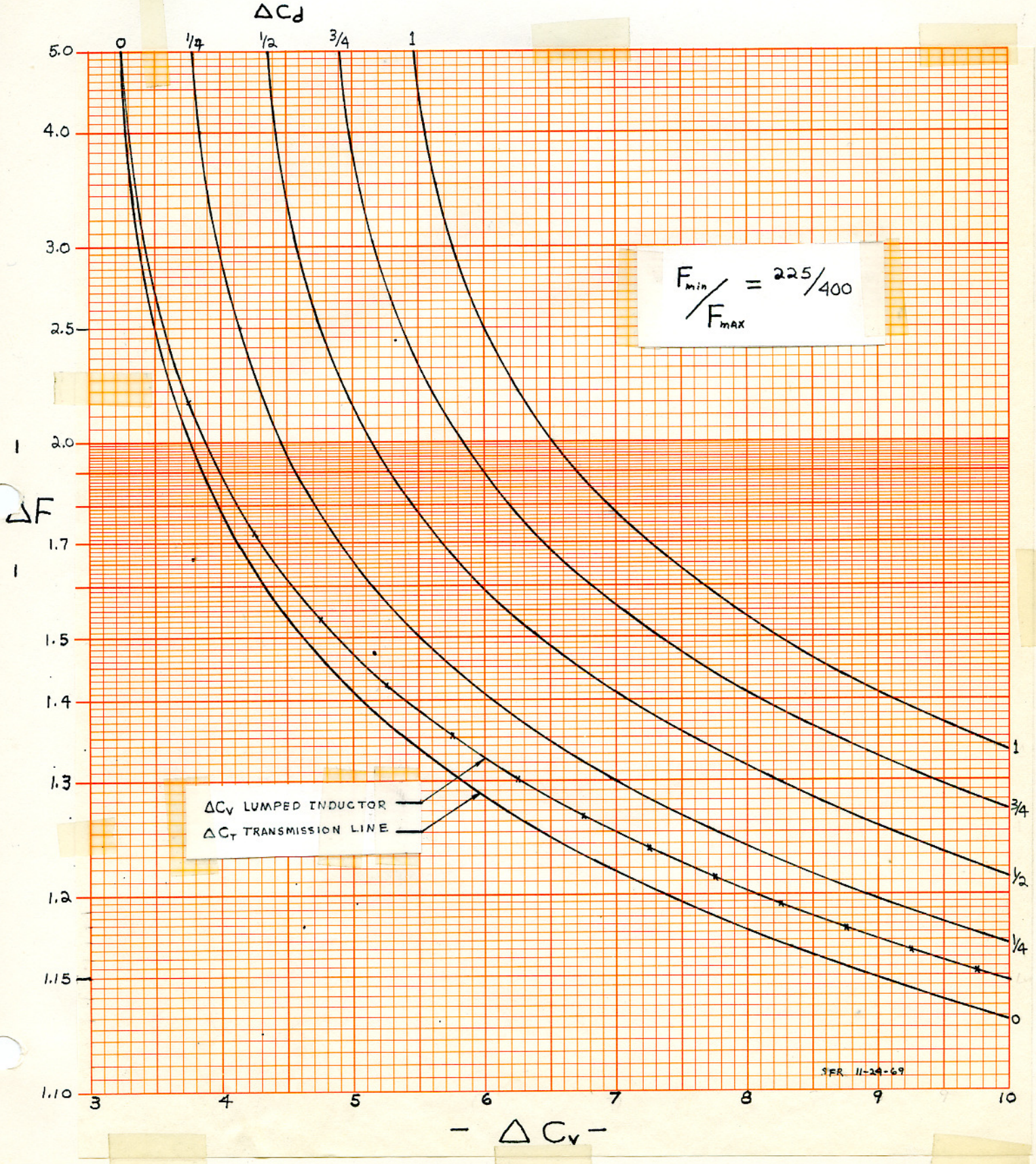

ΔCd
0
1/4
1/2
3/4
1
5.0
4.0
3.0
2.5
2.0
1.7
1.5
1.4
1.3
1.2
1.15
1.10
ΔF
1
1
$F_{min}/F_{max} = 225/400$
ΔCv LUMPED INDUCTOR
ΔCT TRANSMISSION LINE
1
3/4
1/2
1/4
0
SER 11-24-69
3
4
5
6
7
8
9
10
− ΔCv −

Figure 1-10

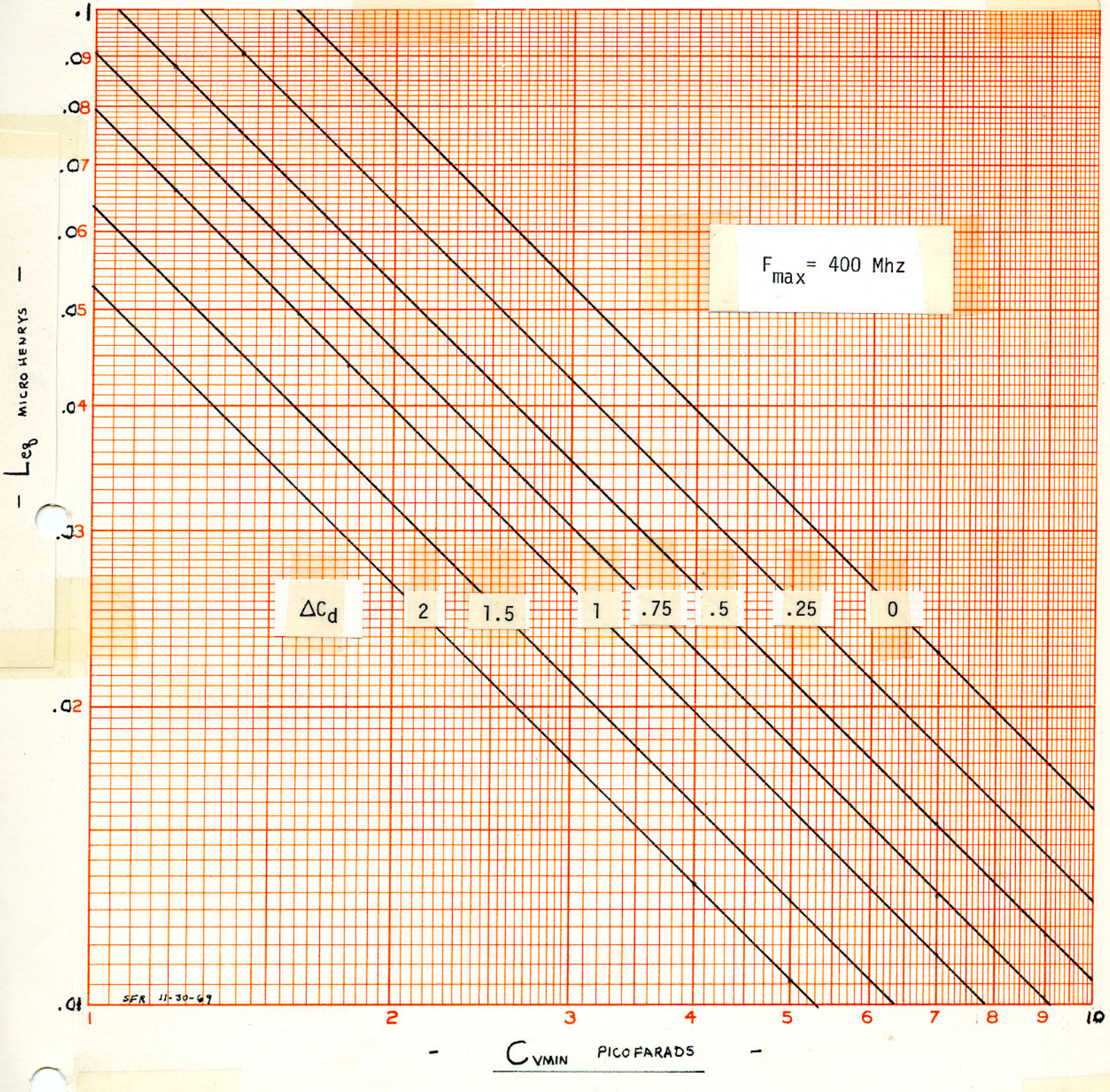

.1
.09
.08
.07
.06
.05
.04
.03
.02
.01
- L_{eq} MICRO HENRYS -
F_{max} = 400 Mhz
ΔC_d
2
1.5
1
.75
.5
.25
0
SFR 11-30-69
1
2
3
4
5
6
7
8
9
10
- C_{VMIN} PICOFARADS -

Figure 1-11

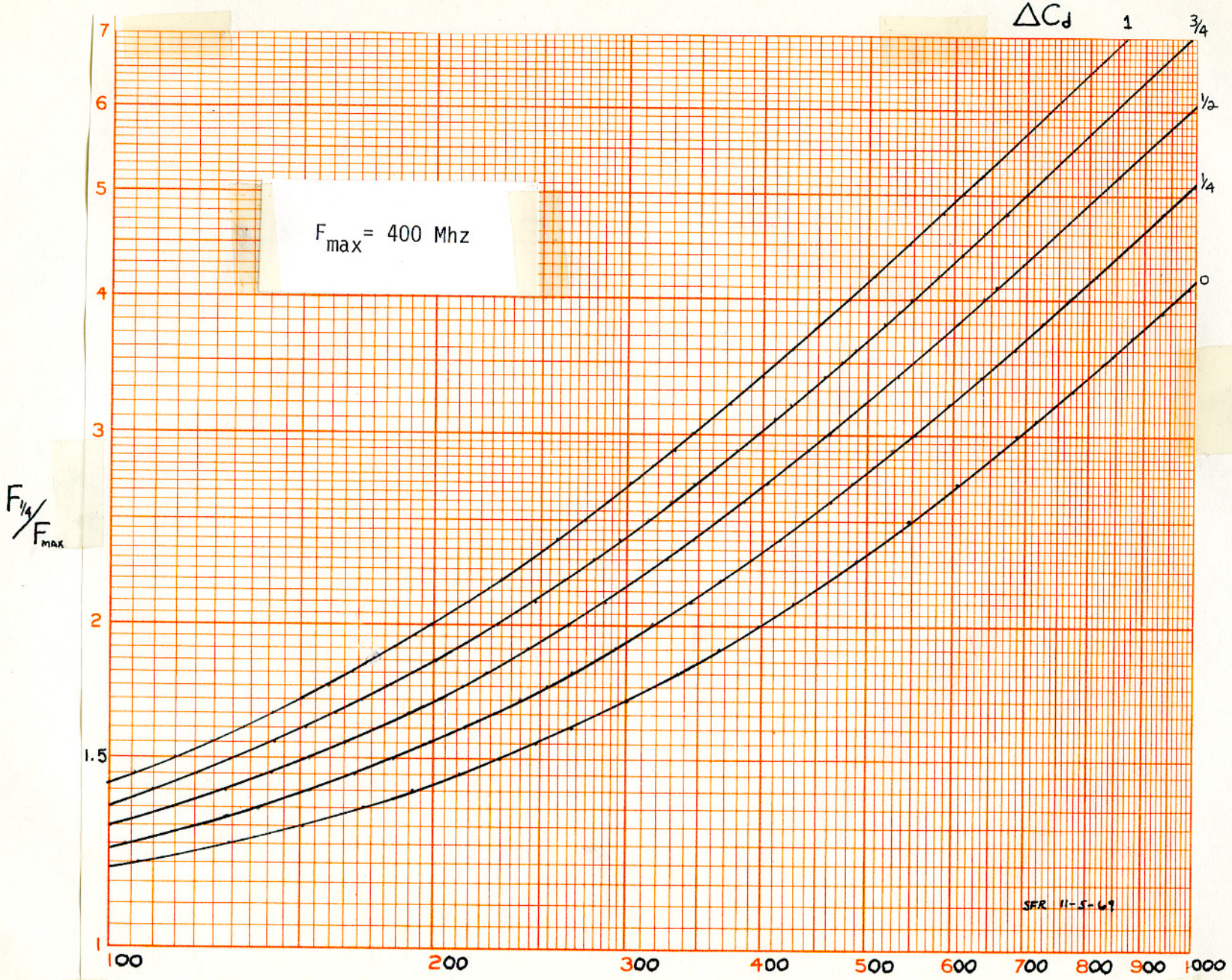

ΔCd
1
3/4
1/2
1/4
0
F_{max} = 400 Mhz
$F_{1/4}/F_{max}$
7
6
5
4
3
2
1.5
1
100
200
300
400
500
600
700
800
900
1000
SFR 11-5-69
$Z_o C_{VMIN}$ OHM- PICO FARADS

Figure 1-12

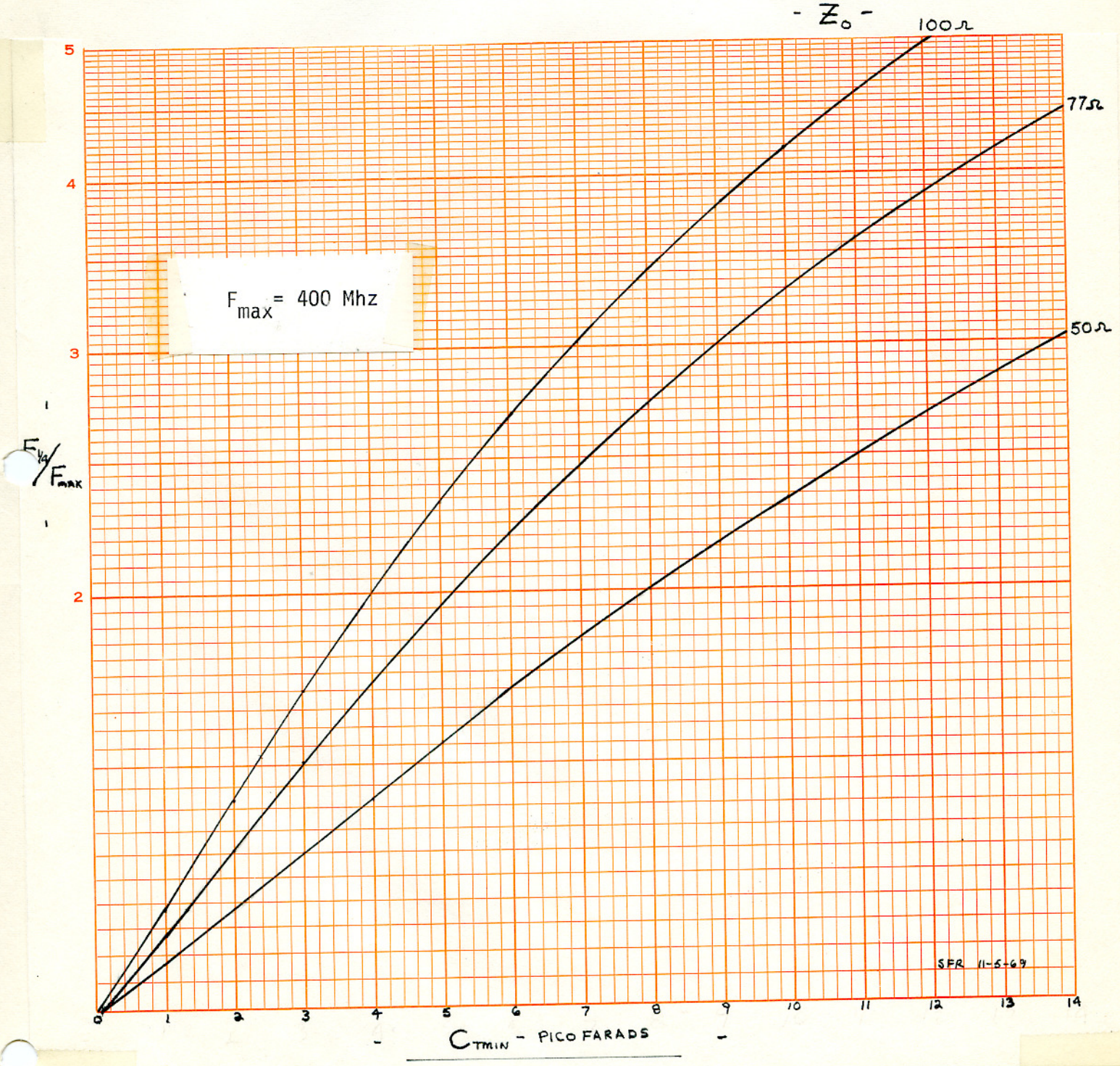

- Z_o -
100Ω
77Ω
50Ω
F_{max} = 400 Mhz
$F_{1/4}/F_{max}$
5
4
3
2
0
1
2
3
4
5
6
7
8
9
10
11
12
13
14
SFR 11-5-69
- C_{TMIN} - PICO FARADS -

Figure 1-13

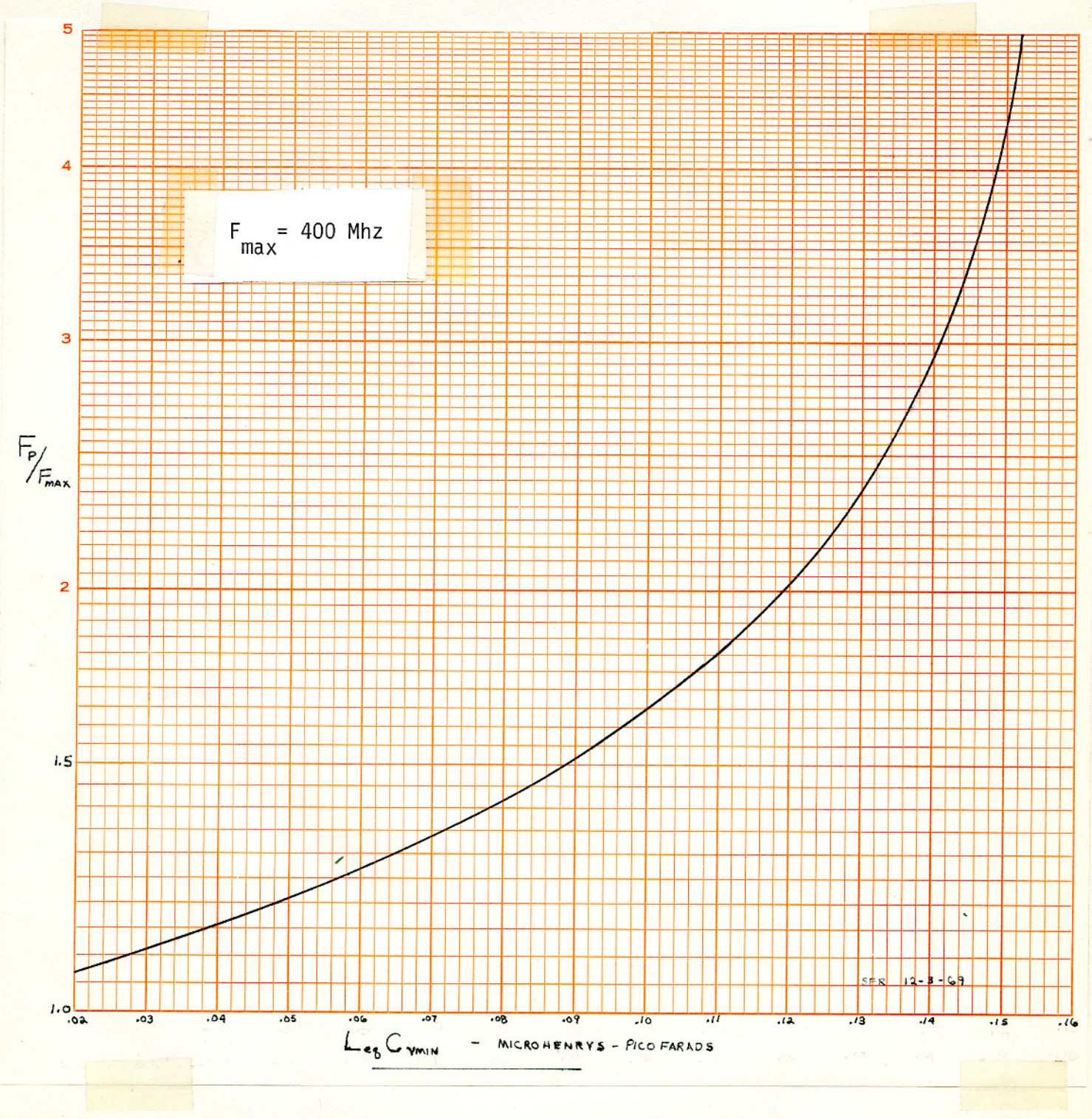

5
4
3
2
1.5
1.0
F_{max} = 400 Mhz
F_P/F_{MAX}
.02
.03
.04
.05
.06
.07
.08
.09
.10
.11
.12
.13
.14
.15
.16
SER 12-3-69
$L_{eq}C_{VMIN}$ - MICROHENRYS - PICO FARADS

Figure 1-14

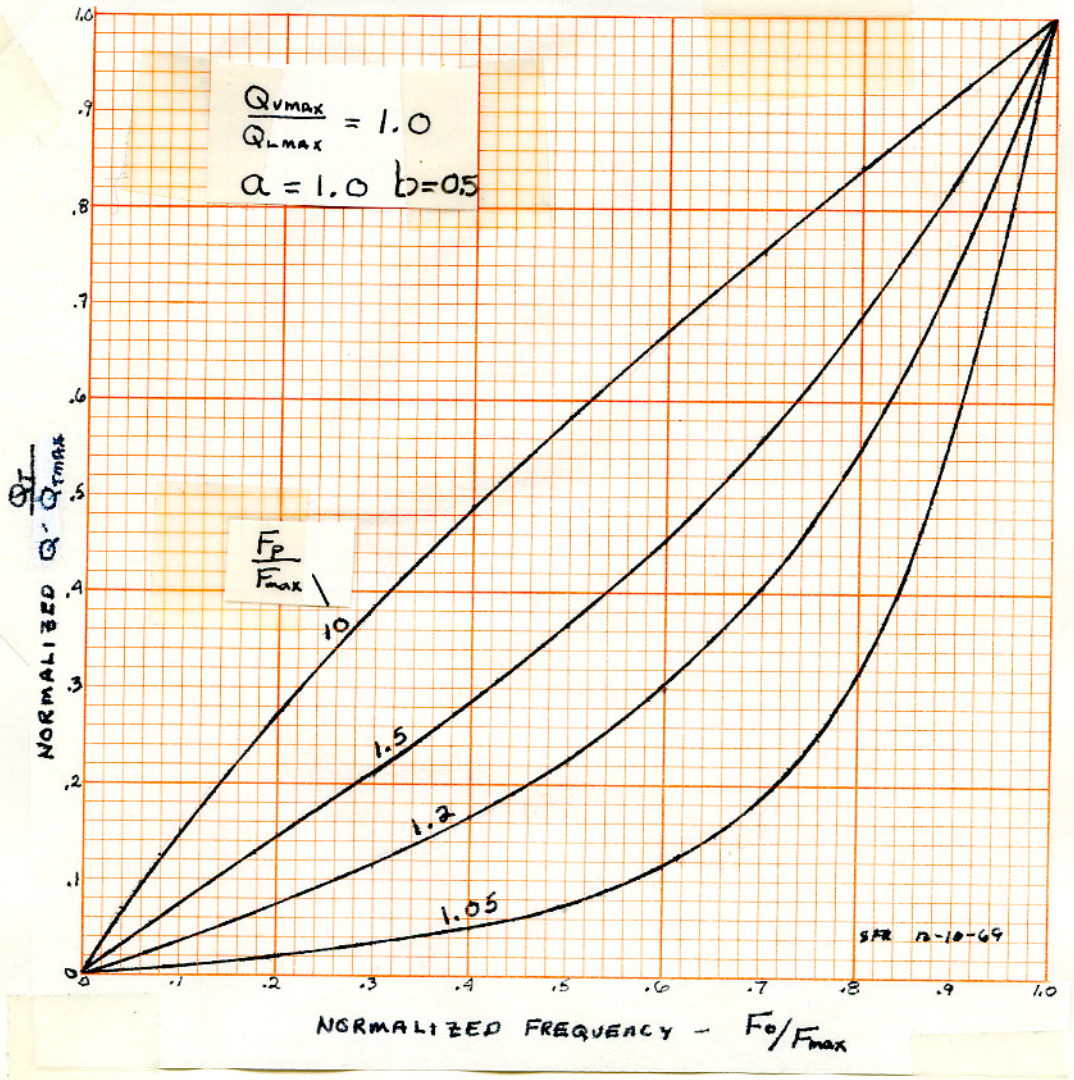

$\frac{Q_{vmax}}{Q_{Lmax}} = 1.0$
a = 1.0 b=0.5
$\frac{F_p}{F_{max}}$
10
1.5
1.2
1.05
SFR 11-10-69
NORMALIZED $\frac{Q_T}{Q_{Tmax}}$
NORMALIZED FREQUENCY - F_o/F_{max}
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0

Figure 1-15

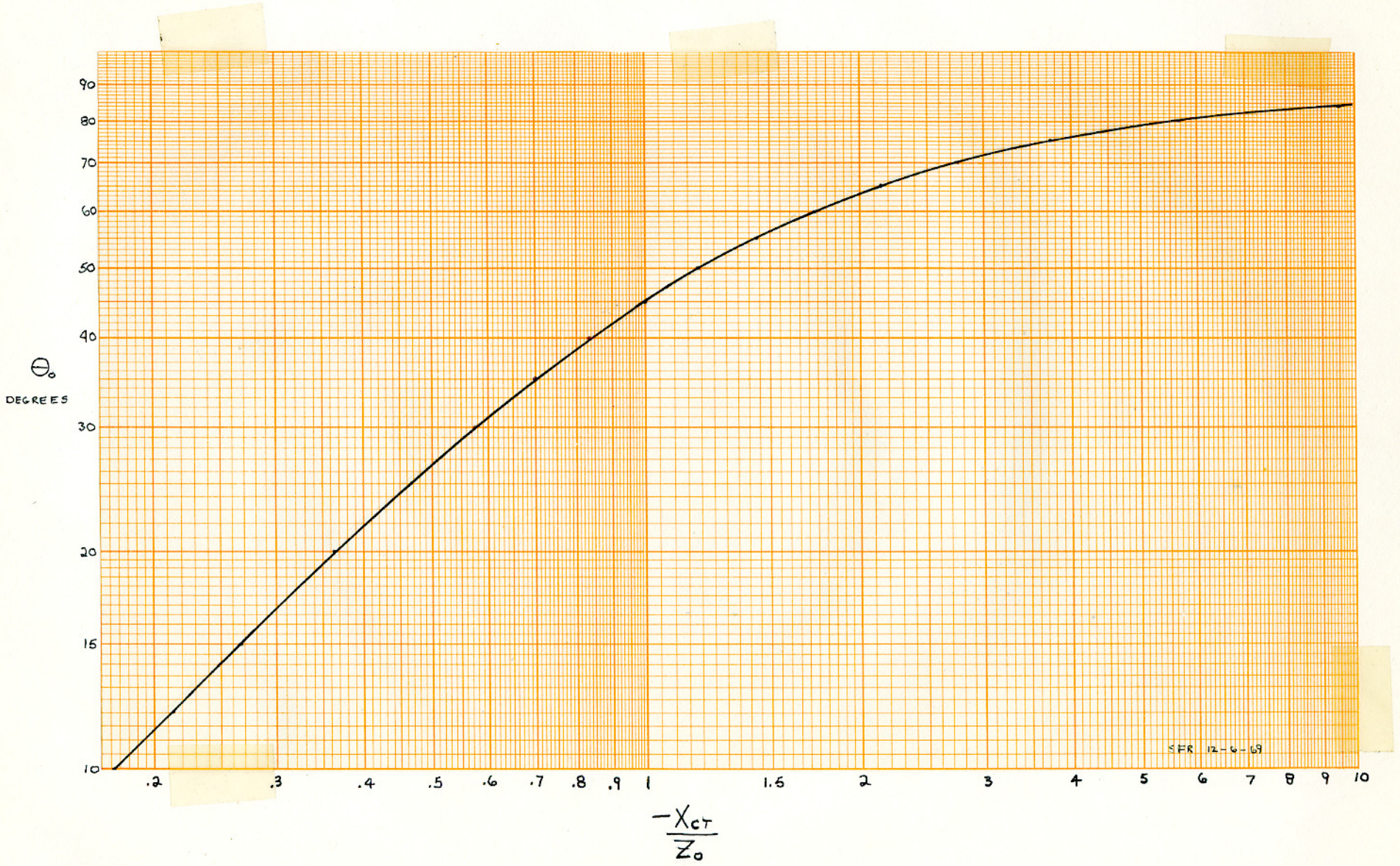

90
80
70
60
50
40
30
20
15
10
Θ_o
DEGREES
.2
.3
.4
.5
.6
.7
.8
.9
1
1.5
2
3
4
5
6
7
8
9
10
$\frac{-X_{CT}}{Z_o}$
SFR 12-6-69

Figure 1-16

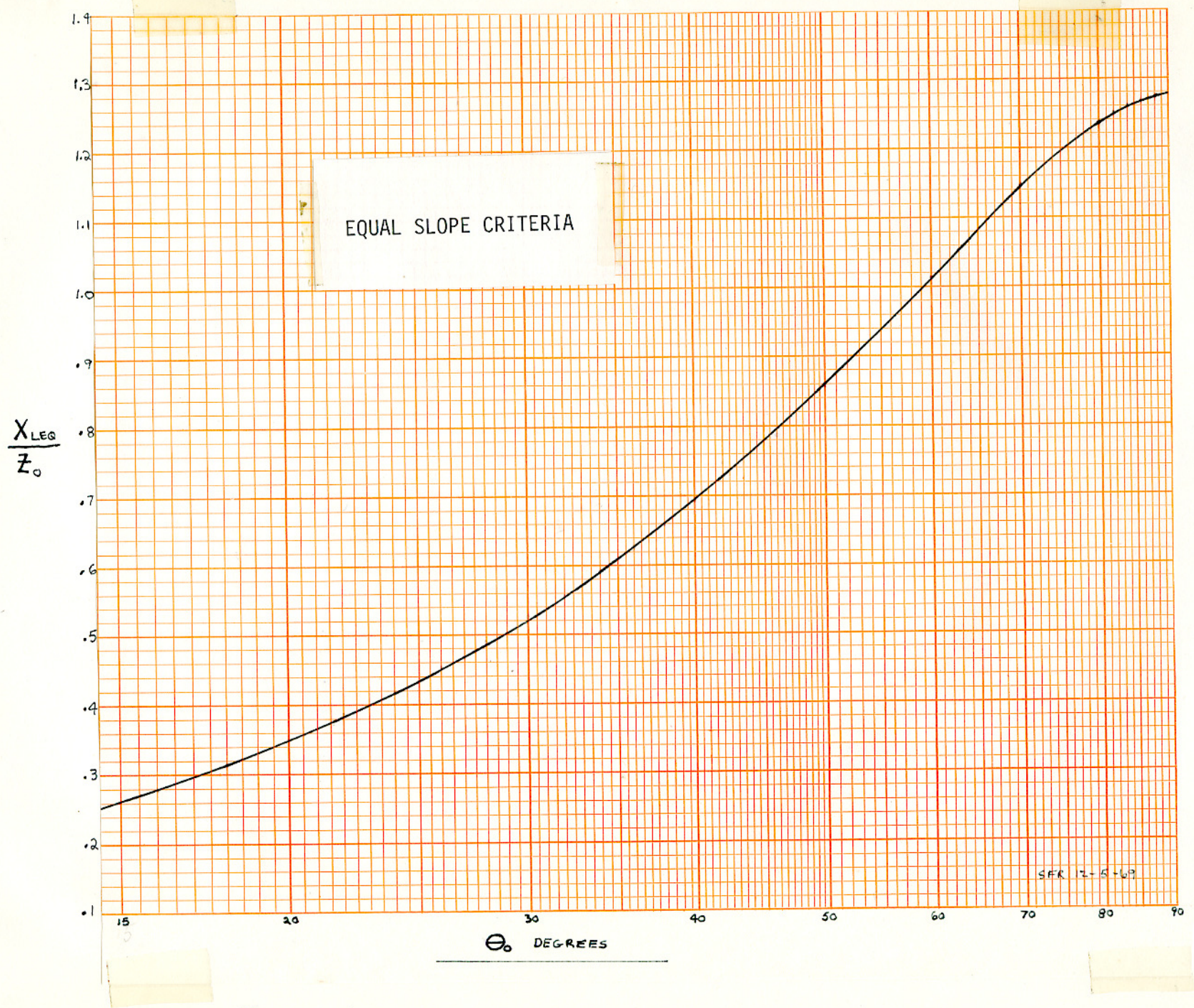

EQUAL SLOPE CRITERIA
$\frac{X_{LEQ}}{Z_o}$
1.4
1.3
1.2
1.1
1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
15
20
30
40
50
60
70
80
90
θ_o DEGREES
SFR 7-5-67

Figure 1-17

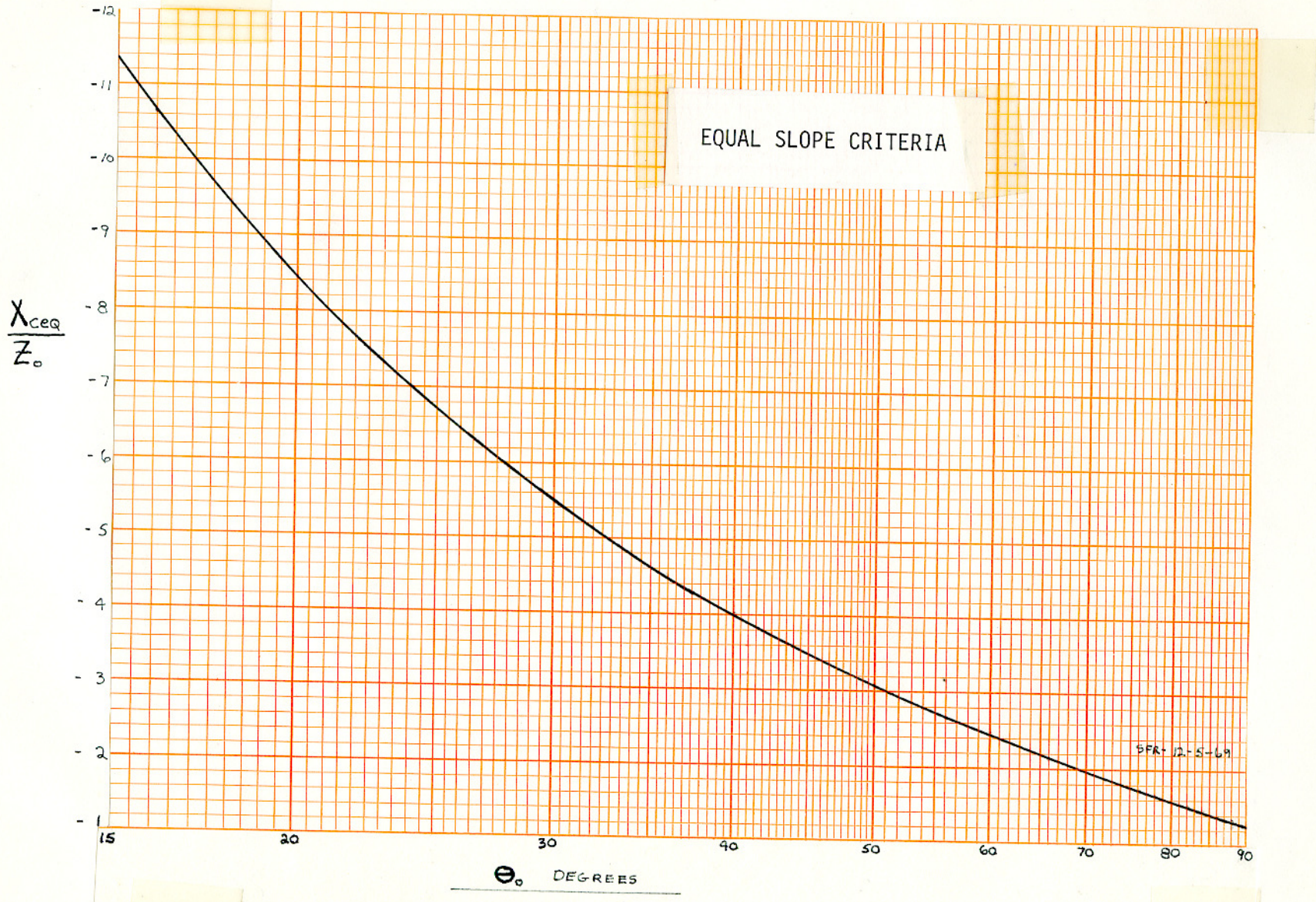

EQUAL SLOPE CRITERIA
$\frac{X_{ceq}}{Z_o}$
-12
-11
-10
-9
-8
-7
-6
-5
-4
-3
-2
-1
15
20
30
40
50
60
70
80
90
Θ_o DEGREES
SFR 12-5-69

Figure 1-18

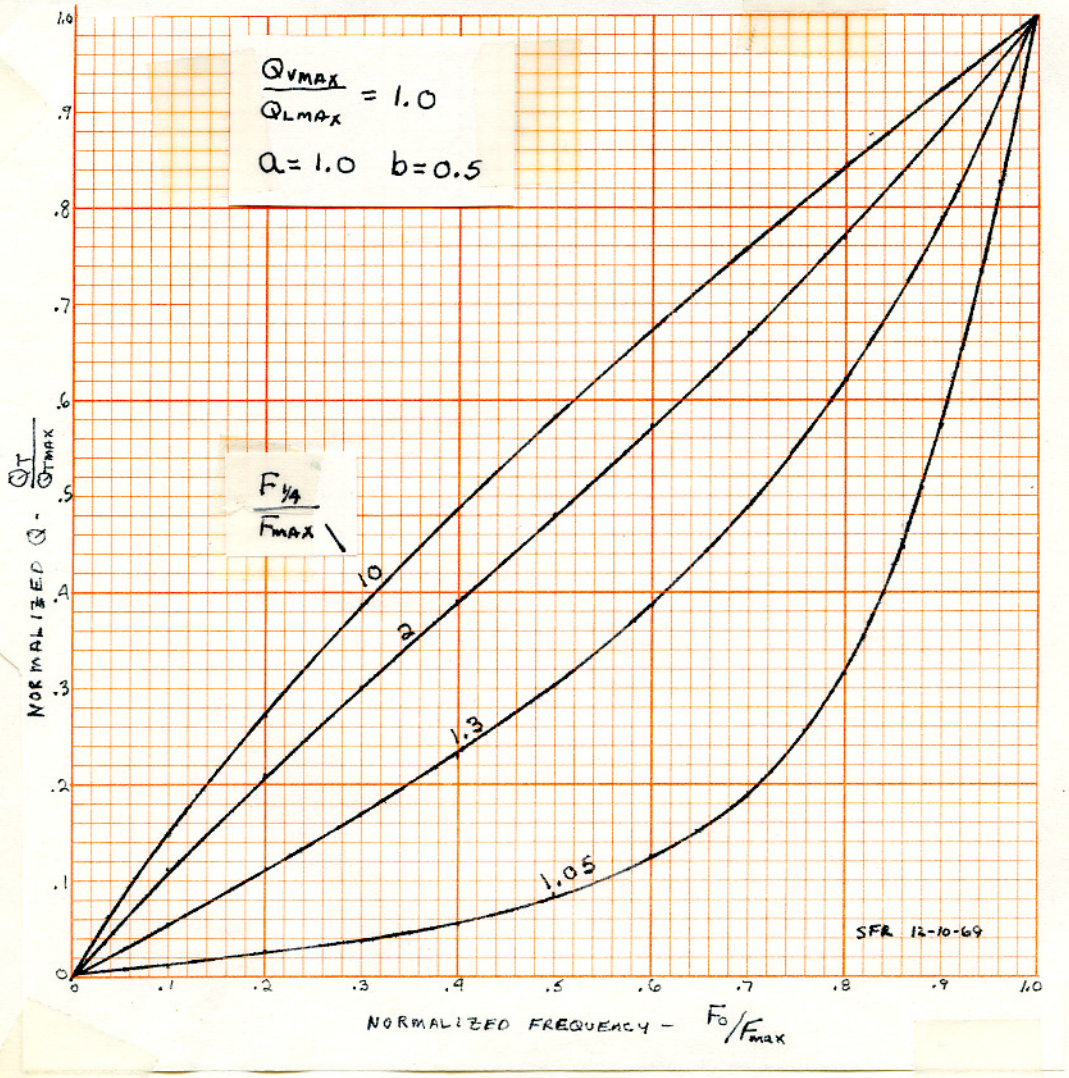

$\frac{Q_{VMAX}}{Q_{LMAX}} = 1.0$
a = 1.0 b = 0.5
$\frac{F_{1/4}}{F_{MAX}}$
10
2
1.3
1.05
SFR 12-10-69
NORMALIZED Q - $\frac{Q_T}{Q_{TMAX}}$
NORMALIZED FREQUENCY - F_o/F_{max}
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0

Figure 1-19

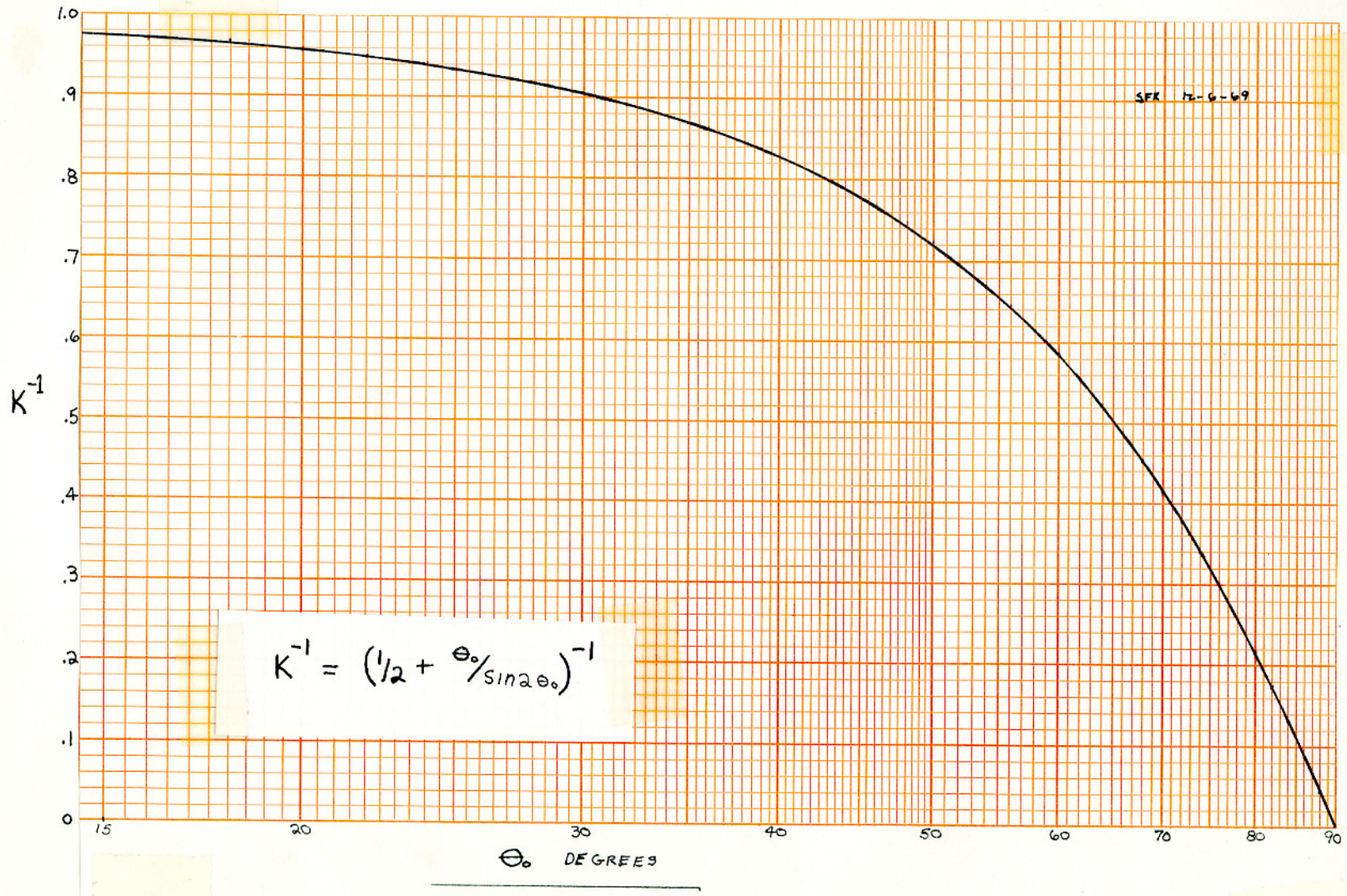

1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
0
K^{-1}
SFR 12-6-69
$K^{-1} = (1/2 + \theta_o/\sin 2\theta_o)^{-1}$
15
20
30
40
50
60
70
80
90
θ_o DEGREES

Figure 1-20

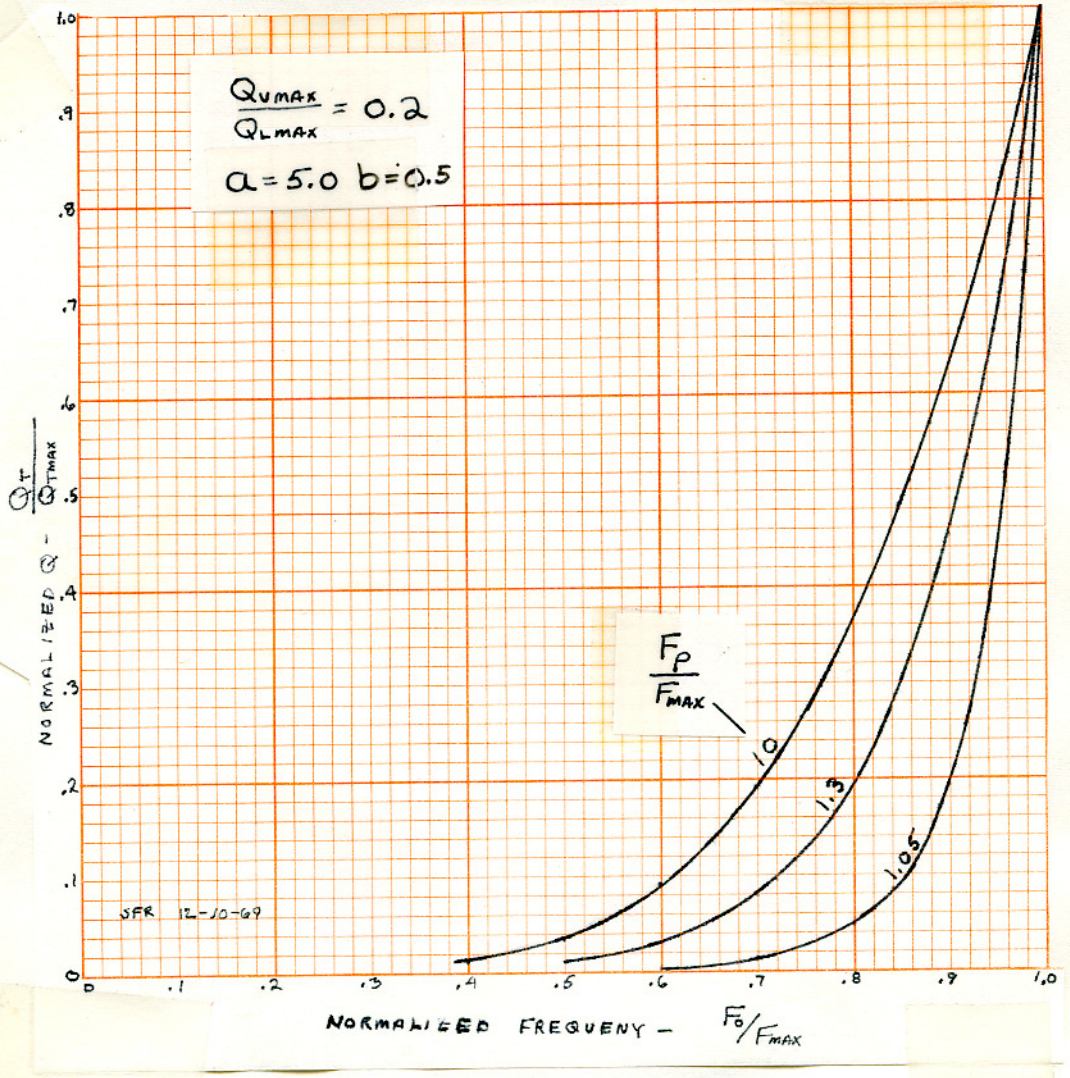

$\frac{Q_{UMAX}}{Q_{LMAX}} = 0.2$
a = 5.0 b = 0.5
$\frac{F_P}{F_{MAX}}$
1.0
1.3
1.05
SFR 12-10-69
NORMALIZED $\frac{Q_T}{Q_{TMAX}}$
NORMALIZED FREQUENY – F_O/F_{MAX}
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0

Figure 1-22

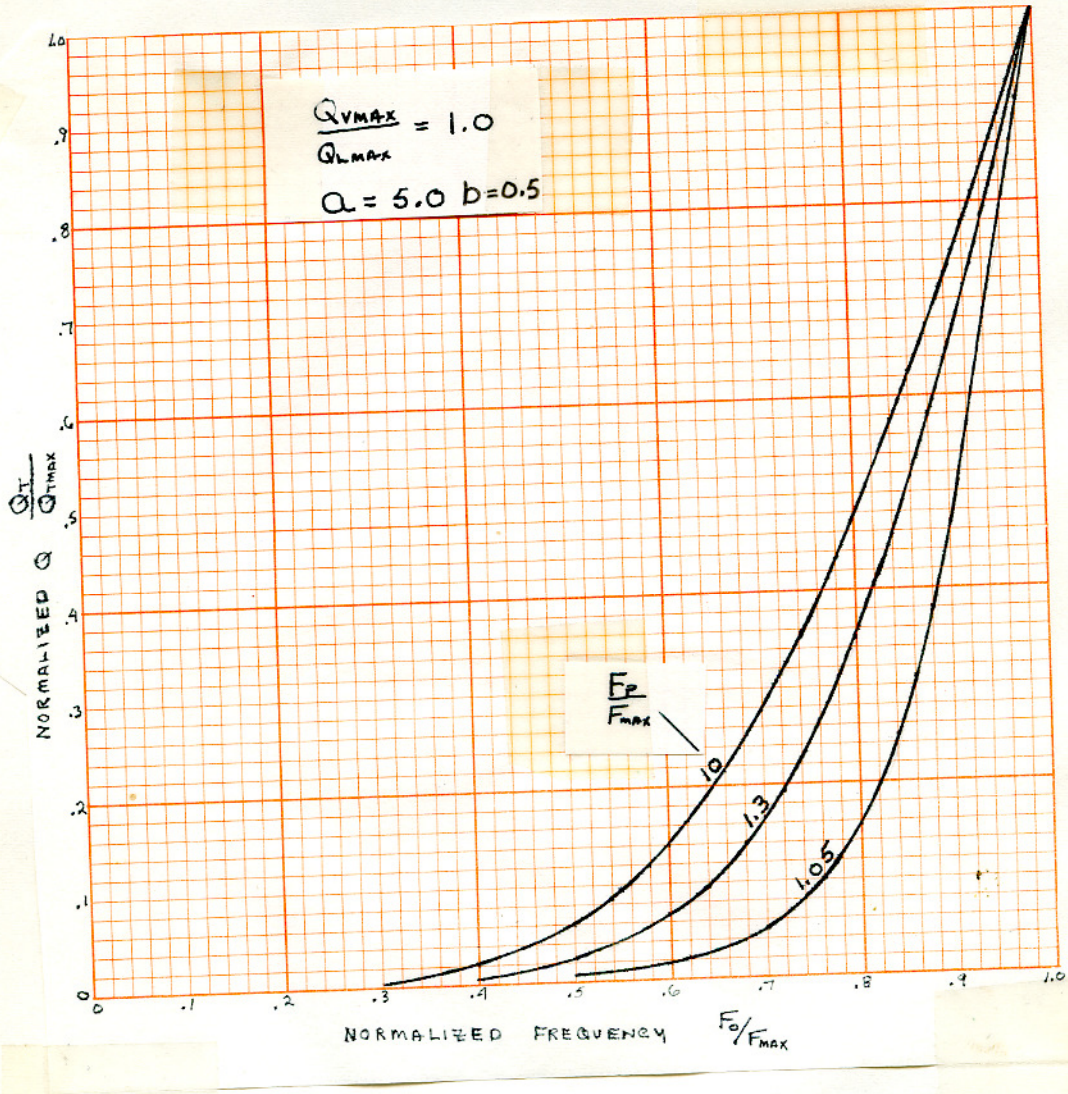

$\frac{Q_{VMAX}}{Q_{LMAX}} = 1.0$
a = 5.0 b=0.5
$\frac{F_P}{F_{MAX}}$
10
1.3
1.05
NORMALIZED Q $\frac{Q_T}{Q_{TMAX}}$
NORMALIZED FREQUENCY F_O/F_{MAX}
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0

Figure 1-23

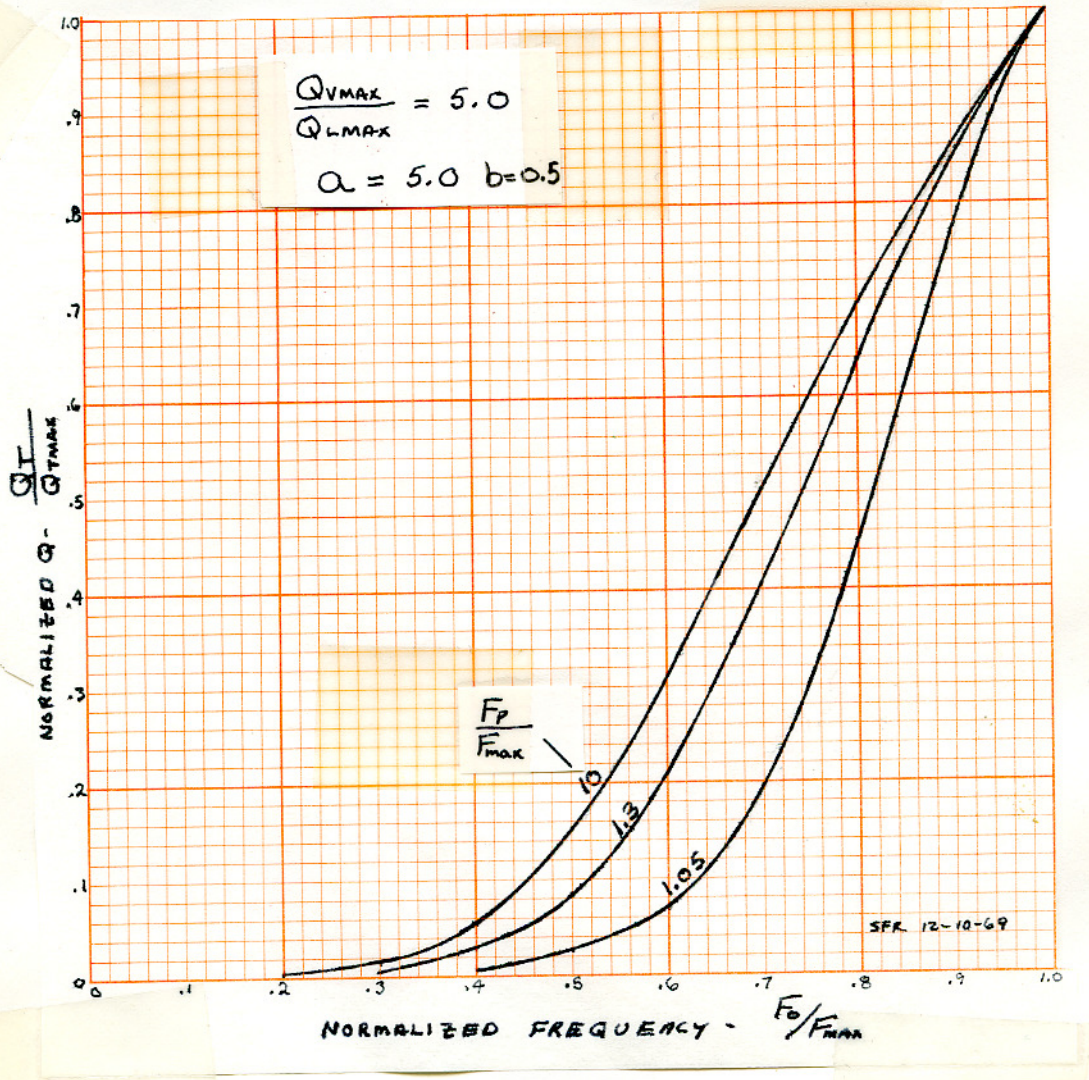

$\frac{Q_{VMAX}}{Q_{LMAX}} = 5.0$
$a = 5.0$ $b = 0.5$
$\frac{F_P}{F_{MAX}}$
10
1.3
1.05
SFR 12-10-69
NORMALIZED Q - $\frac{Q}{Q_{TMAX}}$
NORMALIZED FREQUENCY - F_o/F_{MAX}
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0

Figure 1-24

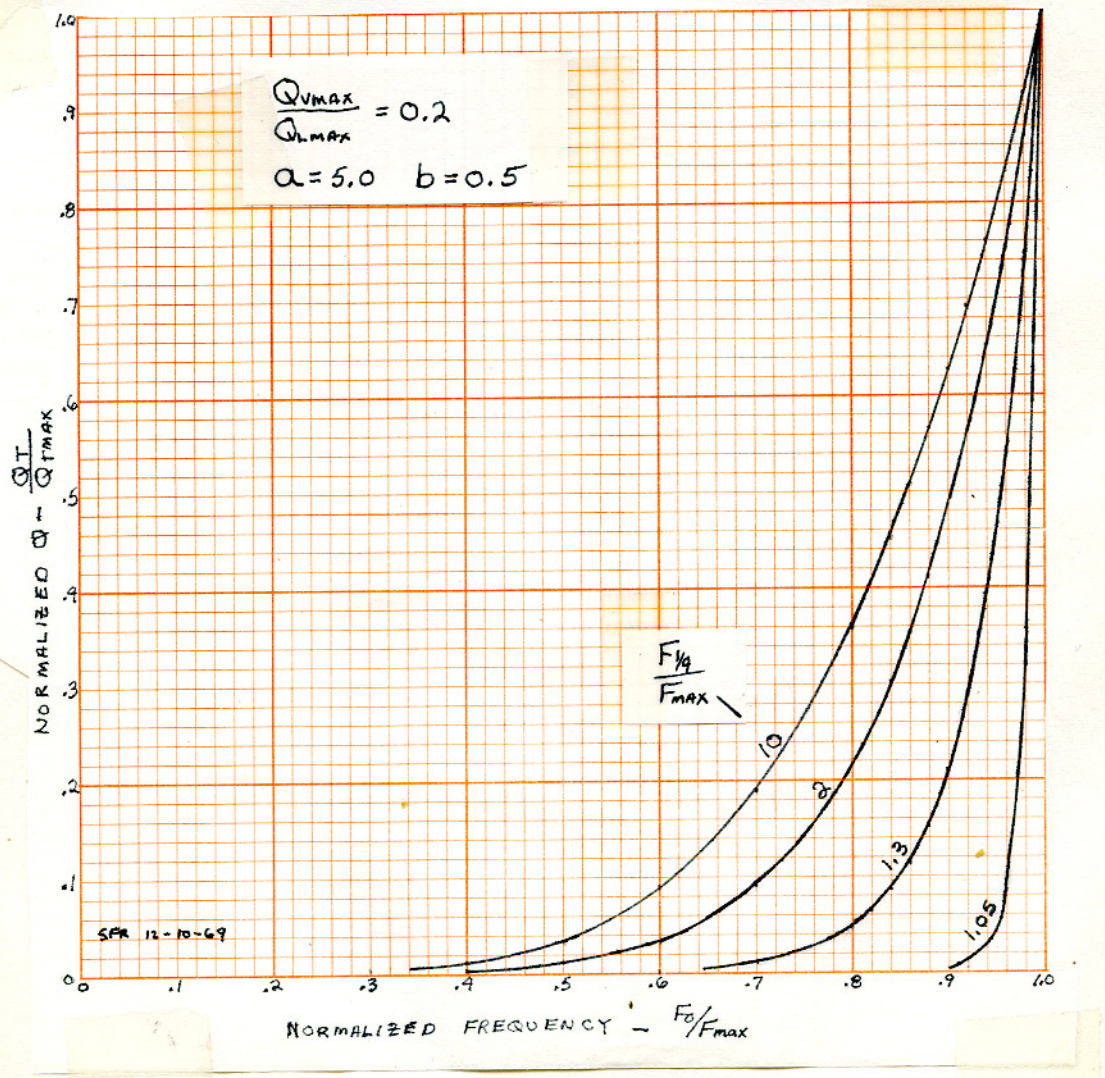

$\frac{Q_{VMAX}}{Q_{LMAX}} = 0.2$
a = 5.0 b = 0.5
$\frac{F_{1/2}}{F_{MAX}}$
10
3
1.3
1.05
SFR 12-10-69
NORMALIZED $\frac{Q_I}{Q_{IMAX}}$
NORMALIZED FREQUENCY — F_O/F_{max}
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0

Figure 1-25

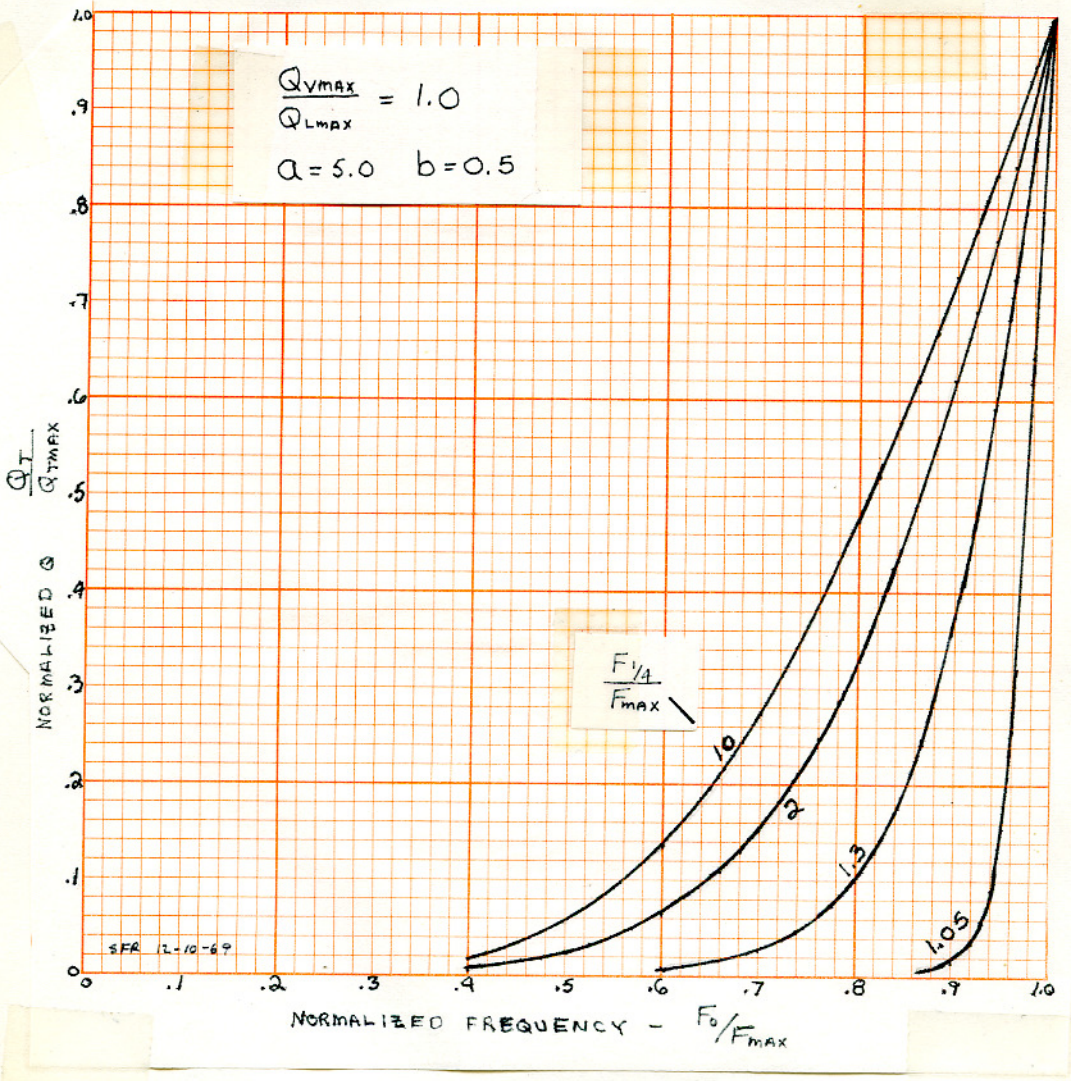

$\frac{Q_{VMAX}}{Q_{LMAX}} = 1.0$
a = 5.0 b = 0.5
$\frac{F_{1/4}}{F_{MAX}}$
10
2
1.3
1.05
SFR 12-10-69
NORMALIZED Q $\frac{Q_T}{Q_{TMAX}}$
NORMALIZED FREQUENCY - F_0/F_{MAX}
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0

Figure 1-26

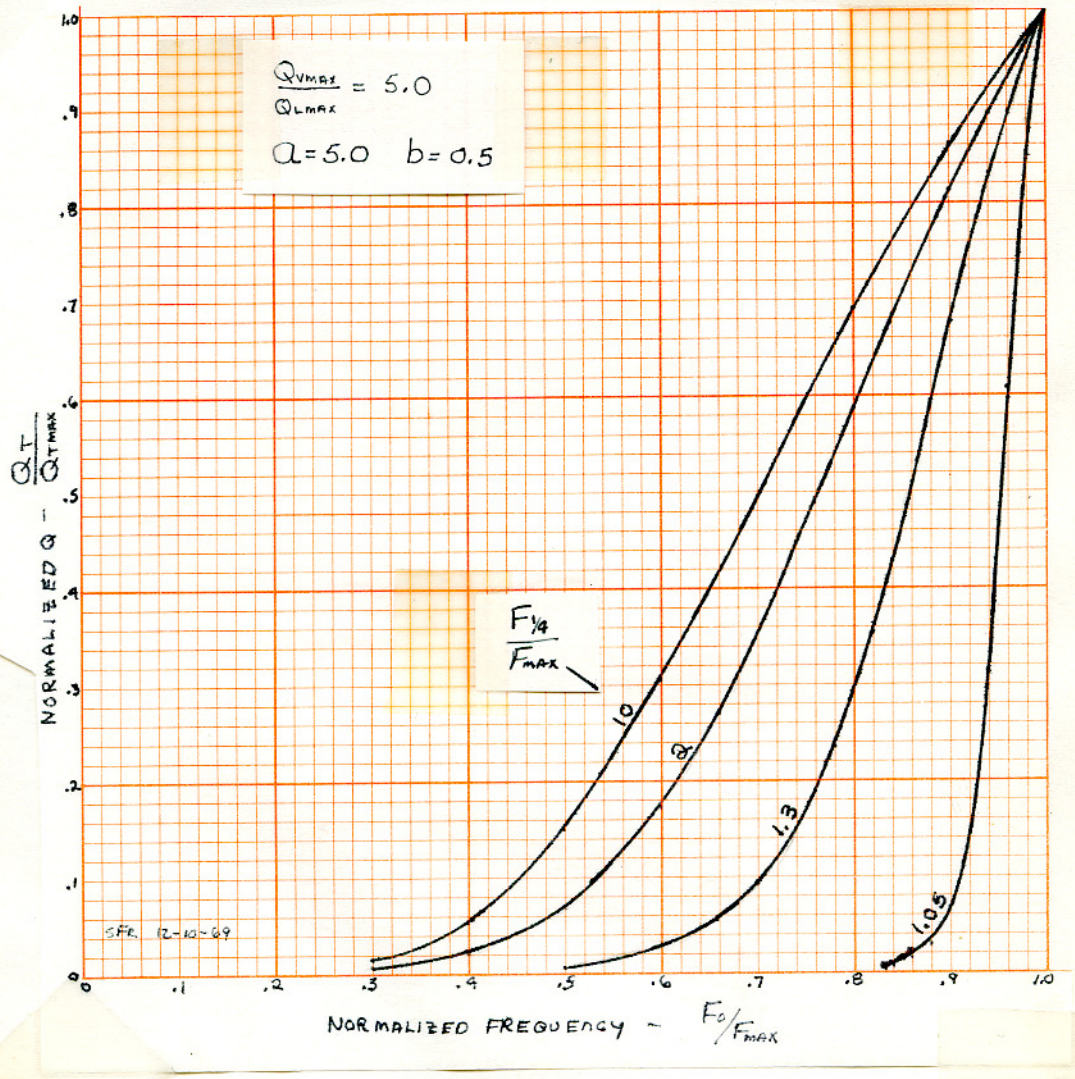

$\frac{Q_{VMAX}}{Q_{LMAX}} = 5.0$
a=5.0 b=0.5
$F_{1/4}/F_{MAX}$
10
2
1.3
1.05
SFR 12-10-69
NORMALIZED Q - Q_T/Q_{TMAX}
NORMALIZED FREQUENCY - F_o/F_{MAX}
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0

Figure 1-27

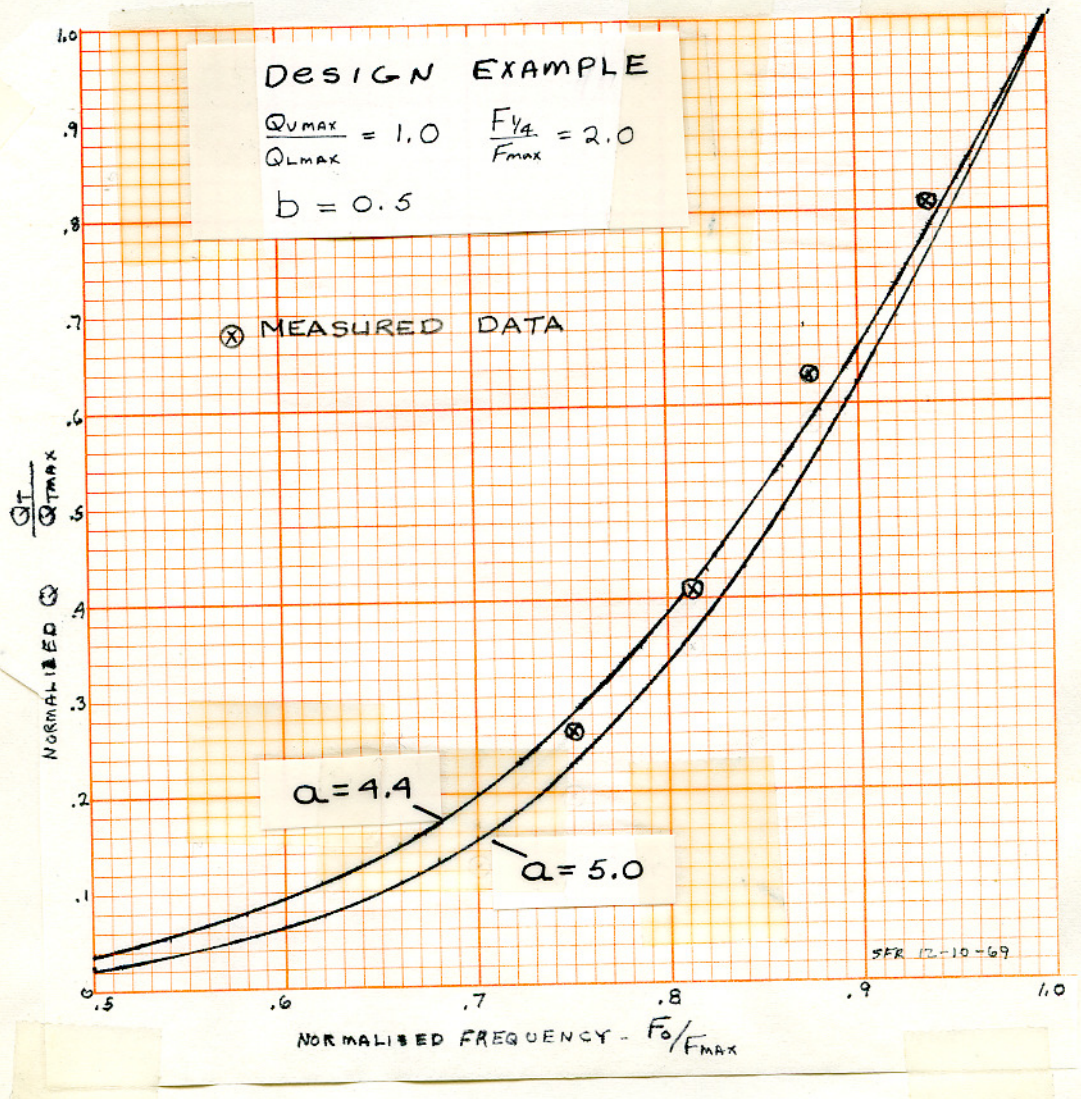

DESIGN EXAMPLE
$\frac{Q_{VMAX}}{Q_{LMAX}} = 1.0$ $\frac{F_{1/4}}{F_{max}} = 2.0$
b = 0.5
⊗ MEASURED DATA
a=4.4
a=5.0
SFR 12-10-69
NORMALIZED $\frac{Q_T}{Q_{TMAX}}$
NORMALISED FREQUENCY - F_o/F_{MAX}
0
.1
.2
.3
.4
.5
.6
.7
.8
.9
1.0
.5
.6
.7
.8
.9
1.0

Figure 1-28

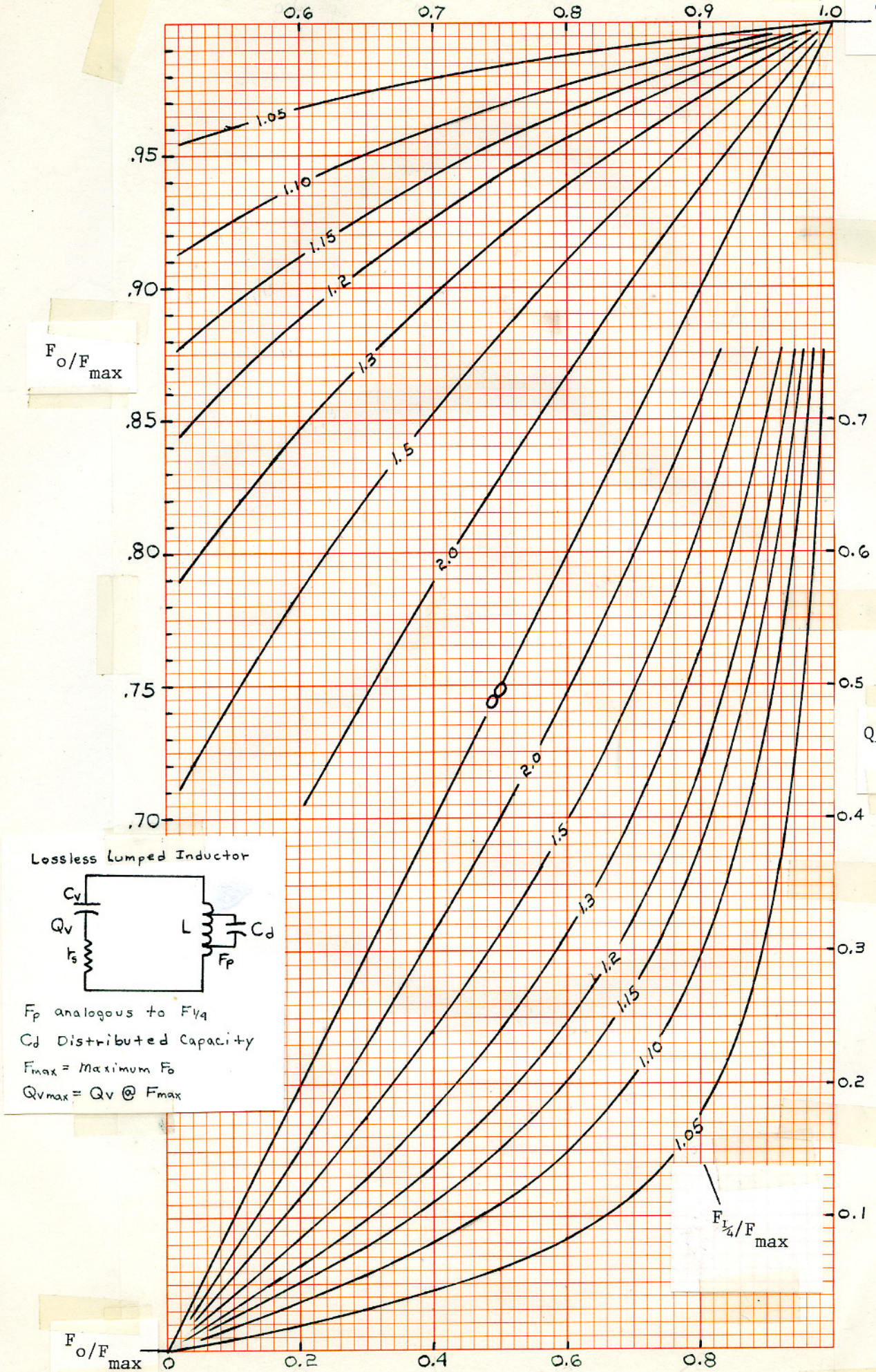
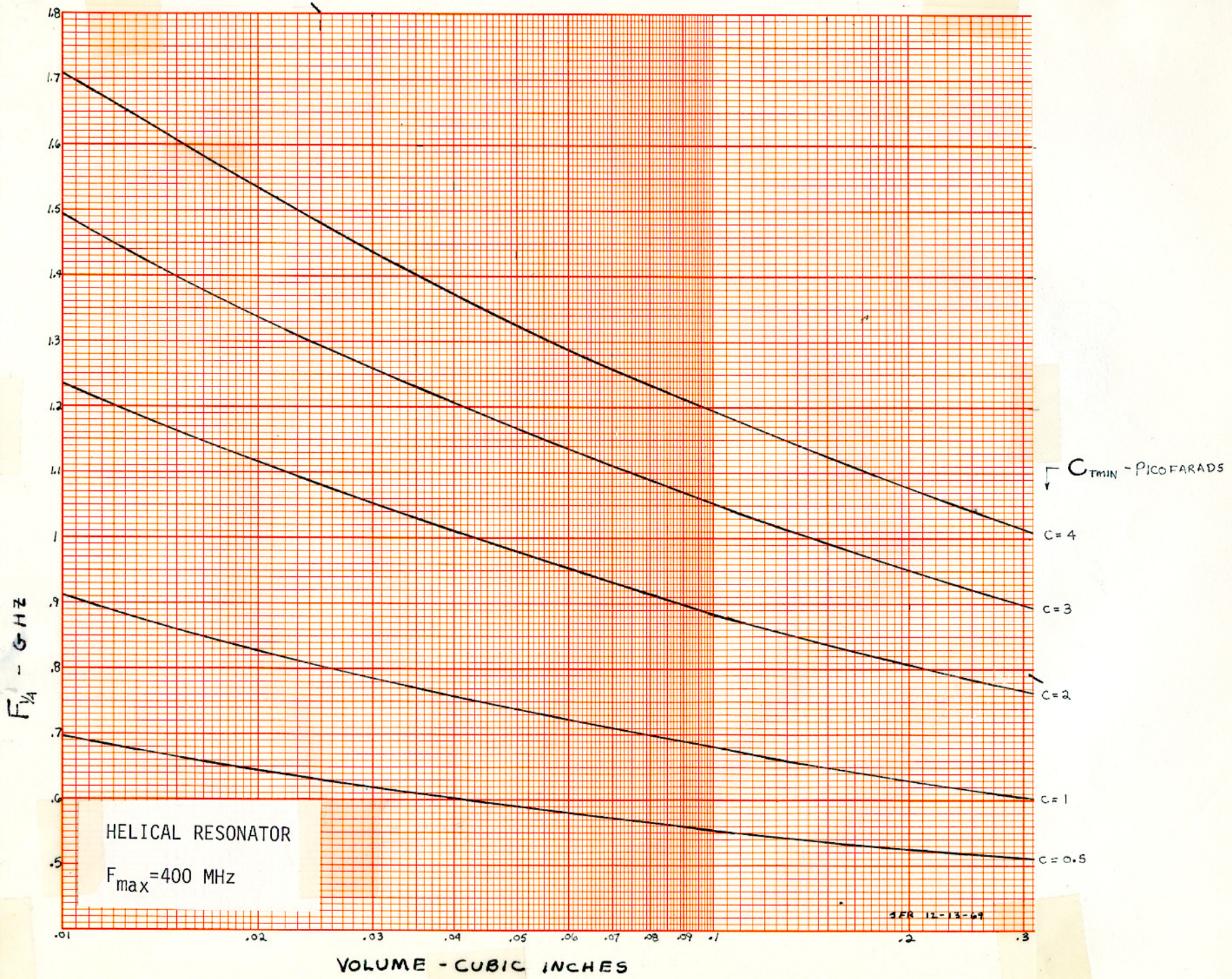
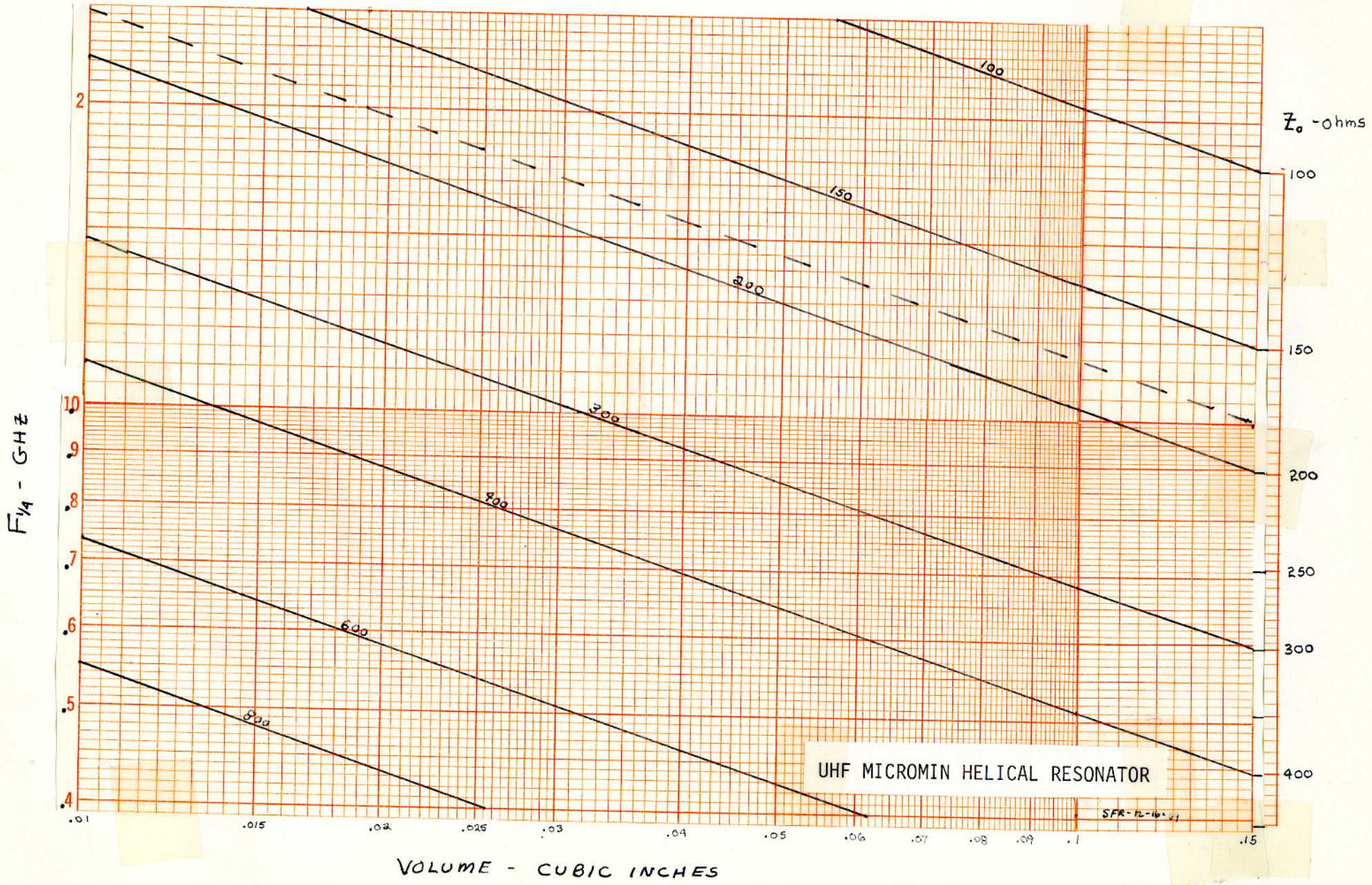
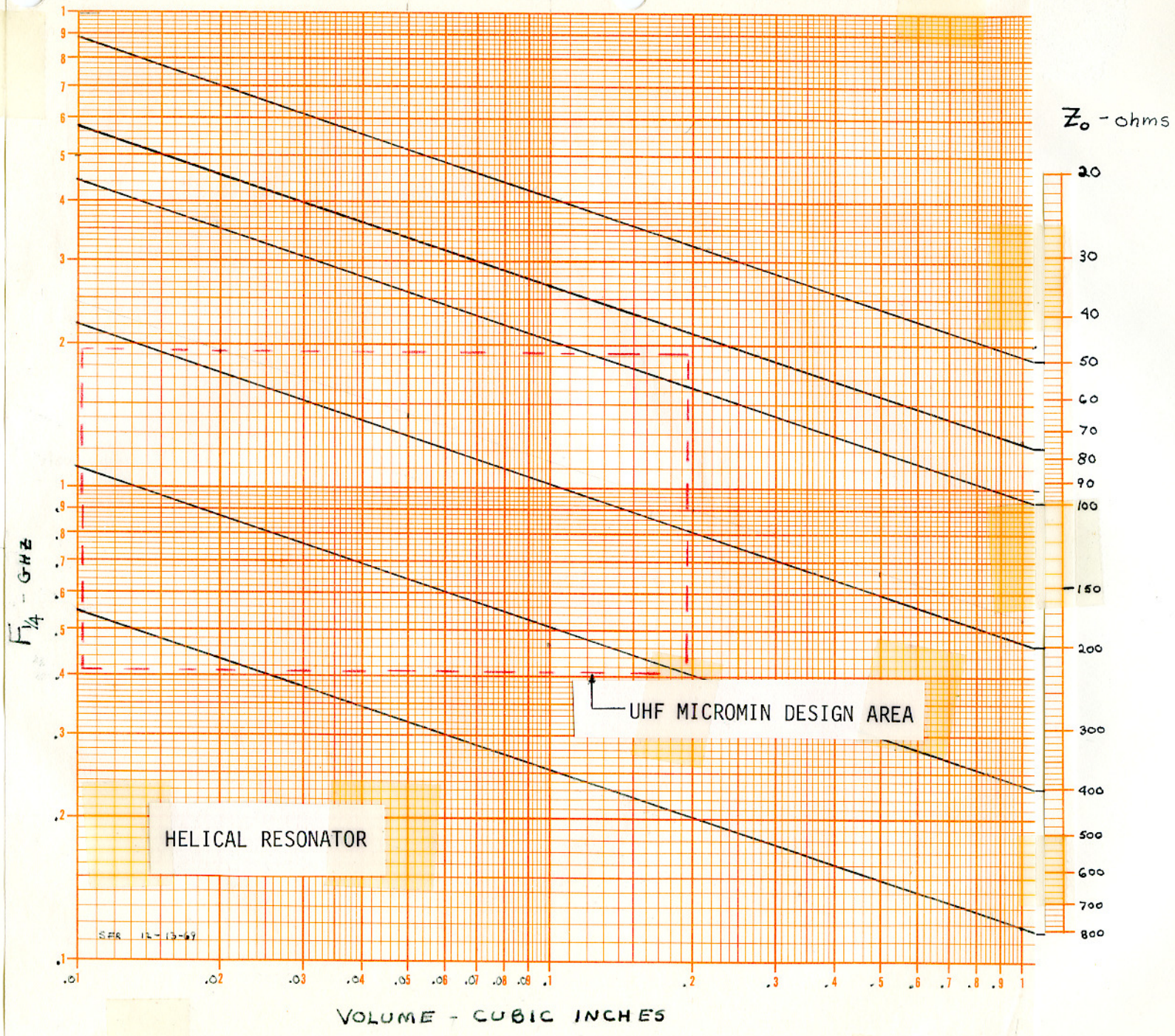
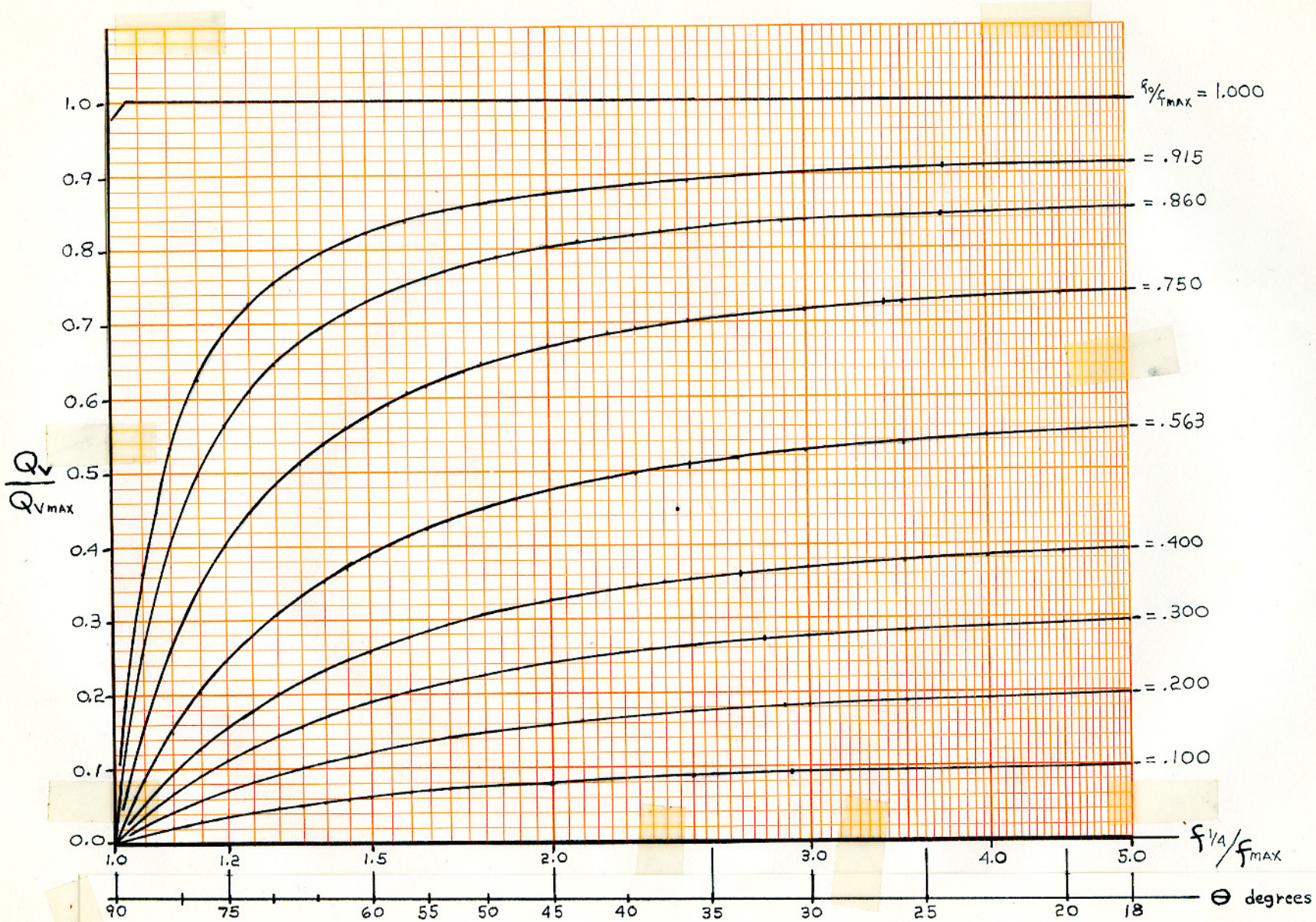

0.6
0.7
0.8
0.9
1.0
$Q_v/Q_{v\ max}$
1.05
1.10
1.15
1.2
1.3
1.5
2.0
∞
.95
.90
.85
.80
.75
.70
F_o/F_{max}
0.7
0.6
0.5
0.4
0.3
0.2
0.1
$Q_v/Q_{v\ max}$
$F_{1/4}/F_{max}$
0
0.2
0.4
0.6
0.8
F_o/F_{max}
Lossless Lumped Inductor
C_v
Q_v
r_s
L
C_d
F_p
F_p analogous to $F_{1/4}$
C_d Distributed Capacity
F_{max} = Maximum F_o
Q_{vmax} = Q_v @ F_{max}

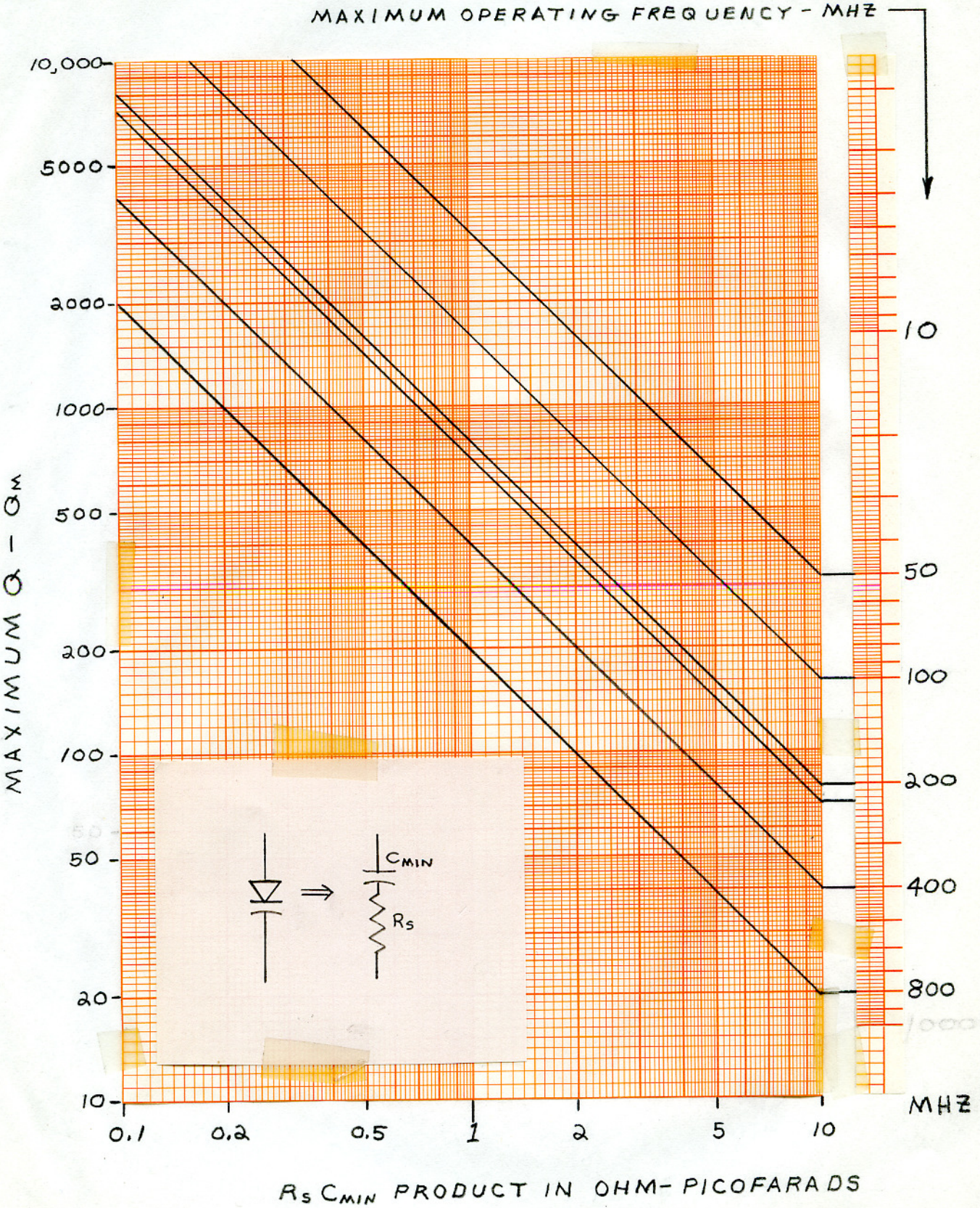
Figure 3.5

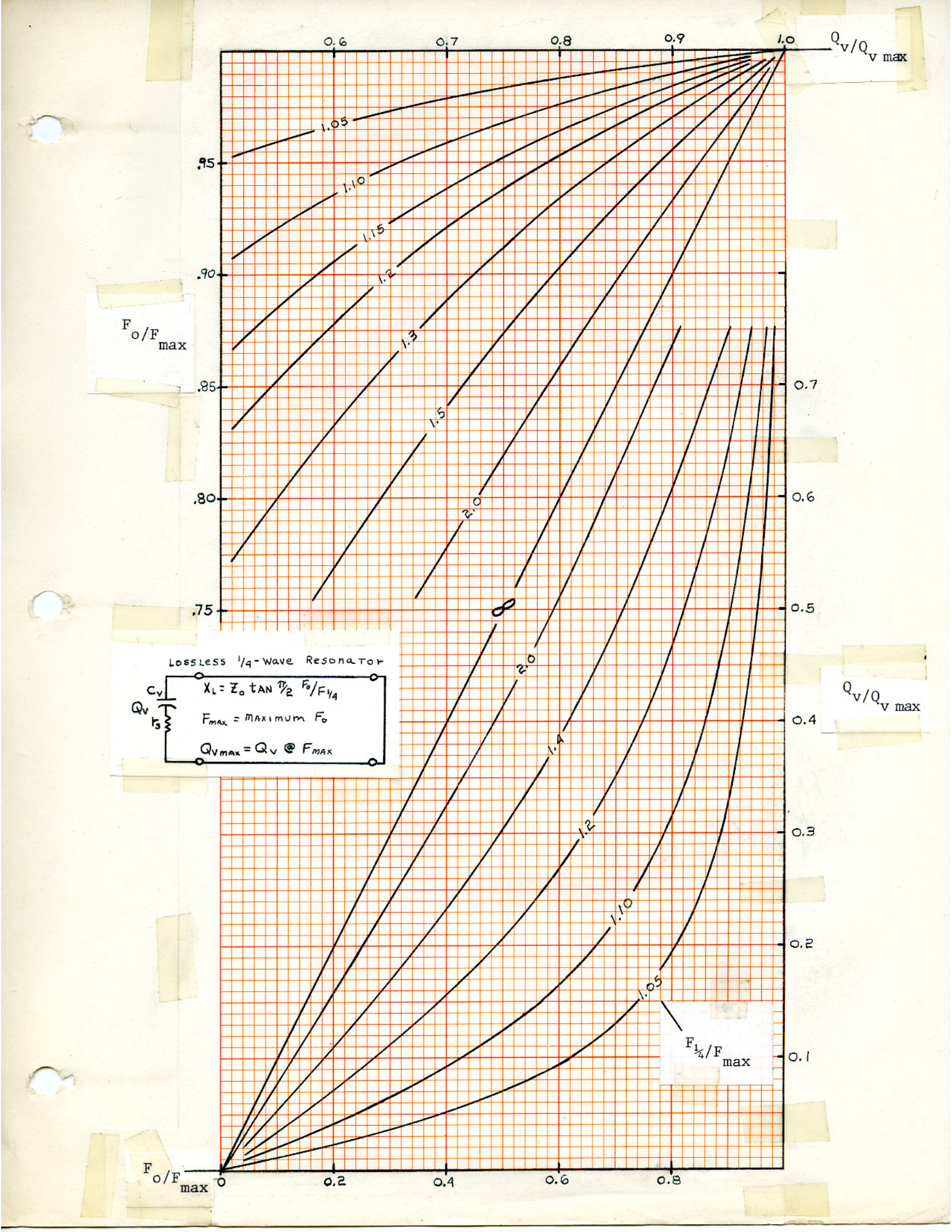

HELICAL RESONATOR
F_{max}=400 MHz
$F_{1/4}$ - GHz
VOLUME - CUBIC INCHES
C_{TMIN} - PICOFARADS
C = 4
C = 3
C = 2
C = 1
C = 0.5
SER 12-13-69
1.8
1.7
1.6
1.5
1.4
1.3
1.2
1.1
1
.9
.8
.7
.6
.5
.01
.02
.03
.04
.05
.06
.07
.08
.09
.1
.2
.3


UHF MICROMIN HELICAL RESONATOR
SFR-12-16-41
F1/4 - GHz
2
1.0
.9
.8
.7
.6
.5
.4
100
150
200
300
400
600
800
.01
.015
.02
.025
.03
.04
.05
.06
.07
.08
.09
.1
.15
VOLUME - CUBIC INCHES
Z0 - ohms
100
150
200
250
300
400


Z_o - ohms
20
30
40
50
60
70
80
90
100
150
200
300
400
500
600
700
800
$f_{1/4}$ - GHz
UHF MICROMIN DESIGN AREA
HELICAL RESONATOR
VOLUME - CUBIC INCHES


$Q_v / Q_{V\,MAX}$
1.0
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0.0
f_0/f_{MAX} = 1.000
= .915
= .860
= .750
= .563
= .400
= .300
= .200
= .100
1.0
1.2
1.5
2.0
3.0
4.0
5.0
$f^{1/4}/f_{MAX}$
90
75
60
55
50
45
40
35
30
25
20
18
Θ degrees


MAXIMUM OPERATING FREQUENCY - MHZ
10,000
5000
2000
1000
500
200
100
50
20
10
MAXIMUM Q - Qm
10
50
100
200
400
800
1000
MHZ
0.1
0.2
0.5
1
2
5
10
CMIN
RS
RS CMIN PRODUCT IN OHM- PICOFARADS


0.6
0.7
0.8
0.9
1.0
$Q_v/Q_{v\ max}$
1.05
1.10
1.15
1.2
1.3
1.5
2.0
∞
.95
.90
.85
.80
.75
F_o/F_{max}
0.7
0.6
0.5
0.4
0.3
0.2
0.1
$Q_v/Q_{v\ max}$
Lossless 1/4-wave Resonator
C_v
Q_v
r_s
$X_L = Z_o \tan \pi/2\ F_o/F_{1/4}$
F_{max} = maximum F_o
$Q_{v\,max} = Q_v$ @ F_{max}
2.0
1.4
1.2
1.10
1.05
$F_{1/4}/F_{max}$
F_o/F_{max}
0
0.2
0.4
0.6
0.8